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REPORT

ON

LAKE STAMFORD

HASKELL COUNTY

TEXAS

EPA REGION VI

WORKING PAPER No. 660

WITH THE COOPERATION OF THE

TEXAS WATER QUALITY BOARD

AND THE

TEXAS NATIONAL GUARD

MARCH, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass

LAKE STAMFORD

STORET NO. 4830

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Stamford is eutrophic; i.e., well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, no nuisance conditions are known to personnel of the Texas Water Quality Board and there is little or no impairment of the designated beneficial uses of this water body.

Lake Stamford ranked twenty-sixth when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Thirty-one of the reservoirs had less median total phosphorus, 22 had less and two had the same median dissolved phosphorus, none had less and one had the same median inorganic nitrogen, 31 had less mean chlorophyll a, and 36 had greater mean Secchi disc transparency.

Survey limnologists observed emergent aquatic plants near station 3 in October, 1974. Blue-green algae were dominant in the August phytoplankton sample.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake because of significant phosphorus losses in the samples during shipment from the field to the laboratory.

* See Appendix A.

The lake data indicate that nitrogen was limiting all four sampling times.

C. Nutrient Controllability:

1. Point sources--The phosphorus contribution of known point sources amounted to 33.6% of the total input to Lake Stamford during the sampling year. The cities of Stamford and Haskell added 18.4% and 15.2% of the total load, respectively, and septic tanks serving lakeshore dwellings and recreation areas contributed an estimated 0.2%.

The present phosphorus loading of 1.44 g/m^2/yr is six times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 13). Even complete removal of phosphorus at the above point sources would still leave a loading nearly four times the eutrophic loading, and it does not seem likely that point-source phosphorus control would result in a significant improvement in the trophic condition of the lake.

2. Non-point sources--Over 66% of the total phosphorus input to Lake Stamford came from non-point sources. Paint Creek contributed 58.1%; Buffalo Creek, 0.8%; and the ungaged tributaries contributed an estimated 6.1% of the total load.

Buffalo Creek had a phosphorus export rate of 5 kg/km²/yr (see page 12). This rate is comparable to that of one of the tributaries of nearby Lake Brownwood* (3 kg/km²/yr). The phosphorus export rate of Paint Creek was 28 kg/km²/yr, which is considerably higher than other tributaries in the vicinity. The higher rate may have results from underestimation of the Stamford load, unidentified point-sources, or both.

* Working Paper No. 836.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 19.00 kilometers^2.

2. Mean depth: 3.5 meters.

3. Maximum depth: ~10.6 meters.

4. Volume: 66,500 x 10^6 m^3.

5. Mean hydraulic retention time: 2.5 years (based on outlet flow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Paint Creek	569.8	0.960
Buffalo Creek	44.5	0.061
Minor tributaries & immediate drainage	299.1	0.490
Totals	913.4	1.511

2. Outlet -

Stamford Aqueduct	0.0	0.850
Paint Creek	932.4	0.001
Totals	932.4**	0.851**

C. Precipitation***:

1. Year of sampling: 54.2 centimeters.

2. Mean annual: 49.0 centimeters.

† Table of metric conversions--Appendix B.
†† Latchford, 1974.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake; lesser outflow due to evaporation (Stearns, 1976).
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Lake Stamford was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at three or four stations on the lake (see map, page vi). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and last visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll *a* analysis. The maximum depths sampled were 10.7 meters at station 1, 4.6 meters at station 2, 4.6 meters at station 3, and 2.4 meters at station 4.

The sampling results are presented in full in Appendix B and are summarized in the following table.

[illegible] SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR STAMFORD LAKE
STUDY CODE [illegible]

PARAMETER	1ST SAMPLING : [illegible] 1974 — 4 SITES			2ND SAMPLING : 5/15/74 — 4 SITES			3RD SAMPLING : [illegible] 1974 — 3 SITES		
	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	14.2 - 17.1	15.5	15.7	23.1 - 26.3	24.9	24.9	25.1 - 25.4	25.8	25.9
[illegible] (MG/L)	7.8 - 9.0	[illegible]	9.0	5.8 - 8.0	7.1	7.1	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PH (STAND UNITS)	8.1 - 8.4	8.2	8.2	8.2 - 8.6	8.4	8.4	8.1 - 8.4	8.3	8.3
TOT ALK (MG/L)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOT P (MG/L)	0.029 - 0.034	0.031	0.030	0.052 - 0.066	0.060	0.059	0.065 - 0.084	0.072	0.070
DIS P (MG/L)	0.007 - 0.014	0.010	0.007	0.035 - 0.044	0.041	0.037	0.051 - 0.062	0.057	0.052
NO2+NO3 (MG/L)	0.030 - 0.035	0.032	0.032	0.038 - 0.051	0.045	0.045	0.040 - 0.059	0.052	0.049
AMMONIA (MG/L)	0.029 - 0.032	0.032	0.032	0.040 - 0.070	0.059	0.060	0.038 - 0.050	0.039	0.040
KJEL N (MG/L)	0.700 - 1.400	0.892	0.850	0.600 - 1.200	0.800	0.700	0.600 - 1.000	0.800	0.750
INORG N (MG/L)	0.350 - 0.330	0.350	0.350	0.070 - 0.350	0.120	0.100	0.050 - 0.070	0.050	0.050
TOTAL N (MG/L)	0.730 - 1.430	0.920	0.885	0.660 - 1.250	0.865	0.750	0.620 - 1.020	0.820	0.770
CHLOPYL A (MG/L)	2.2 - 7.1	3.7	2.6	8.4 - 13.5	10.4	11.0	35.5 - 44.1	40.7	40.4
SECCHI METERS	8.3 - 8.6	8.5	8.5	8.1 - 8.4	8.3	8.3	8.5 - 8.7	8.6	8.6

[illegible] SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR STAMFORD LAKE
STREET ISLE [illegible]

[illegible] SAMPLING [illegible]

PARAMETER	3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	17.1 - 18.1	17.4	17.4
DISS OXY (MG/L)	7.6 - 9.8	8.3	8.4
CNDCTVY (MICROMO	1063. - 1105.	1077.	1086.
PH (STAND UNITS)	[illegible]	[illegible]	[illegible]
TOT ALK (MG/L)	147. - 152.	149.	149.
TOT P (MG/L)	0.262 - 0.285	0.269	0.277
DFTHO P (MG/L)	0.018 - 0.027	0.019	0.025
NO2+NO3 (MG/L)	0.025 - 0.029	0.028	0.028
AMMONIA (MG/L)	0.029 - 0.050	0.033	0.030
KJEL N (MG/L)	0.980 - 1.400	1.073	1.000
INORG N (MG/L)	0.648 - 0.878	0.853	0.858
TOTAL N (MG/L)	0.828 - 1.428	0.948	0.928
CHLOPHYL A (UG/L)	21.5 - 25.6	23.4	23.7
SECCHI (METERS)	8.3 - 8.6	8.4	8.5

8. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/07/74	1. Ankistrodesmus sp.	1,327
	2. Synedra sp.	601
	3. Lunate cells	526
	4. Dactylococcopsis sp.	351
	5. Chroomonas sp.	200
	Other genera	677
	Total	3,682
05/15/74	1. Centric diatoms	2,563
	2. Microcystis sp.	1,923
	3. Diplonels sp.	838
	4. Chroomonas sp.	739
	5. Ankistrodesmus sp.	345
	Other genera	1,086
	Total	7,493
08/05/74	1. Oscillatoria sp.	2,239
	2. Lyngbya sp.	2,183
	3. Raphidiopsis sp.	1,567
	4. Anabaenopsis sp.	1,119
	5. Cryptomonas sp.	1,007
	Other genera	2,910
	Total	11,025
10/28/74	1. Diplonels sp.	4,088
	2. Oscillatoria sp.	2,732
	3. Dactylococcopsis sp.	1,629
	4. Coelosphaerium sp.	1,534
	5. Chroomonas sp.	1,246
	Other genera	1,869
	Total	13,098

B. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/07/74	1	2.6
	2	2.2
	3	2.0
	4	2.1
05/15/74	1	8.4
	2	8.7
	3	12.5
	4	14.0
08/05/74	1	31.9
	2	41.4
	3	49.3
10/28/74	1	26.6
	2	23.7
	3	21.6

C. Limiting Nutrient Study:

Due to significant losses of phosphorus in the samples from the time of collection to the beginning of the algal assays, the results are not representative of the conditions in the lake at the times the samples were taken (03/07/74 and 10/28/74).

The lake data indicate that nitrogen was the limiting nutrient all four sampling times. The mean inorganic nitrogen to orthophosphorus ratios were 9 to 1 in March, 11 to 1 in May, 4 to 1 in August, and 3 to 1 in October.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of May when two samples were collected. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean nutrient concentrations in Buffalo Creek, at station C-1 and the mean annual ZZ flow.

The operator of the Haskell wastewater treatment plant provided monthly effluent samples and corresponding flow data. The City of Stamford did not participate; nutrient loads from this source were estimated at 1.134 kg P and 3.401 kg N/capita/year, and flows were estimated at 0.3785 m^3/capita/day.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Haskell*	3,560	stab. pond	1,165.6	Rice Springs Branch
Stamford**	4,461	tr. filter	1,604.7	Stink Creek

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Paint Creek	15,935	58.1
Buffalo Creek	210	0.8
b. Minor tributaries & immediate drainage (non-point load) -	1,670	6.1
c. Known municipal STP's -		
Haskell	4,180	15.2
Stamford	2,840	10.4
d. Septic tanks*** -	50	0.2
e. Known industrial - None	-	-
f. Direct precipitation**** -	335	1.2
Total	27,425	100.0

2. Outputs -

Lake outlet - Stamford Aqueduct) 2,310
Paint Creek

3. Net annual P accumulation - 25,115 kg.

* Jacob, 1974.
** Anonymous, 1971
*** Estimate based on 160 dwellings and three parks; see Working Paper No. 175.
**** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Paint Creek	53,525	42.9
Buffalo Creek	2,230	1.8
b. Minor tributaries & immediate drainage (non-point load) -	17,910	14.4
c. Known municipal STP's -		
Haskell	13,555	10.9
Stamford	15,140	12.1
d. Septic tanks* -	1,810	1.5
e. Known industrial - None	-	-
f. Direct precipitation** -	20,510	16.4
Total	124,680	100.0

2. Outputs -

Lake outlet - Stamford Aqueduct) 34,515
Paint Creek

3. Net annual N accumulation - 90,165 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Paint Creek	28	94
Buffalo Creek	5	50

* Estimate based on 160 dwellings and three parks; see Working Paper No. 175.
** See Working Paper No. 175.

E. Mean Nutrient Concentrations in Ungaged Stream:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Mule Creek*	1.542	7.200

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m²/yr	1.44	1.32	6.6	4.7

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Stamford:

"Dangerous" (eutrophic loading)	0.24
"Permissible" (oligotrophic loading)	0.12

* Sampling station downstream from Haskell STP.

V. LITERATURE REVIEWED

Jacob, Billy, 1974. Treatment plant questionnaire (Haskell STP). Abilene.

Latchford, John D., Jr., 1974. Personal communication (lake morphometry). TX Water Quality Board, Austin.

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Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

[illegible] DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INDEX S	[illegible] SEC	[illegible] CALORIES	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible] CITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ENGLE [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible] LITTLE ELK RESERVE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	PALESTINE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	E F SPENCE RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Data To Be Used In Regression

[illegible] Code	[illegible] Name	[illegible] Total, P	[illegible] Inflow, I	[illegible] [illegible] Sec	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] OF LAKES WITH [illegible] HOLES RANKED BY LAKES WITH MORE HOLES

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INSPS N	SEC [illegible] SEC	[illegible] CHLORA	[illegible] [illegible]	[illegible] DISS [illegible] P	INDEX NO
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible] CITY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	EAGLE [illegible] LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	FT PHANTOM HILL LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GARZA LITTLE ELM RESERVO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	HOW LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]STON LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE OF THE PINES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAVON RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LEWISVILLE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LYNDON B JOHNSON LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	MEDINA LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAKE [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	PALESTINE LAKE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN ANGELO RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SAN [illegible] RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	E O SPENCE RESERVOIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] OF LAKES [illegible] VALUES [illegible] OF LAKES [illegible] VALUES)

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] [illegible] %	[illegible] [illegible] SEC	[illegible] CHLOPH	[illegible] [illegible] 10	[illegible] [illegible] [illegible]	[illegible] [illegible]
[illegible]	[illegible]	29 (113)	55 (213)	24 (93)	3 (11)	67 (259)	38 (147)	259
[illegible]	[illegible]	19 (73)	47 (177)	5 (21)	18 (71)	62 (237)	39 (149)	259
[illegible]	[illegible]	69 (259)	37 (141)	67 (259)	42 (161)	17 (61)	56 (219)	372
[illegible]	[illegible]	32 (123)	70 (269)	37 (141)	21 (81)	63 (241)	38 (147)	253
[illegible]	[illegible]	11 (41)	51 (199)	13 (51)	16 (61)	72 (279)	13 (51)	176
[illegible]	[illegible]	39 (241)	34 (133)	61 (233)	45 (173)	17 (61)	21 (71)	217
[illegible]	[illegible]	68 (229)	21 (71)	92 (351)	82 (313)	17 (61)	64 (243)	586
[illegible]	[illegible]	9 (81)	91 (229)	11 (41)	5 (21)	92 (351)	8 (81)	369
[illegible]	[illegible]	59 (223)	21 (71)	58 (223)	91 (339)	49 (179)	63 (241)	381
[illegible]	[illegible]	84 (329)	91 (229)	76 (291)	69 (261)	17 (61)	63 (231)	348
[illegible]	[illegible]	63 (241)	51 (199)	79 (301)	71 (271)	17 (61)	76 (289)	357

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	[illegible]	LYNDON B JOHNSON LAKE	239
30	[illegible]	TOWN LAKE	237
31	[illegible]	STACYVILLE LAKE	236
32	[illegible]	SAN ANGELO RESERVOIR	233
33	[illegible]	TEXARKANA LAKE	176
34	[illegible]	BIRCH LITTLE ELM RESERVOIR	173
35	[illegible]	TYNDOM	169
36	[illegible]	BRANDS LAKE	159
37	[illegible]	CORPUS CHRISTI LAKE	155
38	[illegible]	HOUSTON LAKE	139
39	[illegible]	LIVINGSTON LAKE	91

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

| | | |

APPENDIX D

PHYSICAL and CHEMICAL DATA

[illegible]

APPENDIX E

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

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[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	&	TOTAL	[illegible]	
TO	DAY	FEET	MG/L	MG/L	MG/L	MG/L #	MG/L #
74/10/28	12	10	1.121	2.388	0.135	1.458	1.348
74/11/23	13	09	5.2834	1.885	0.825	1.579	1.683
75/02/25	26	38	14.888	8.468	3.624	1.683	1.920
75/03/15	12	10	9.782	3.498	0.135	1.728	2.498
75/04/25			5.681	1.488	0.186	1.288	1.468
75/09/21			8.810	2.258	0.856	1.348	1.985
75/10/26			8.463	2.488	0.895	0.356	1.378

* VALUE [illegible] TO BE
LESS THAN PREDICTED

[illegible]

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

DATE	TIME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	12	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	13	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] RETRIEVAL DATE [illegible]

[illegible]
33 57 10.8 [illegible]
[illegible]
[illegible] 7.5 STAMFORD
[illegible] STAMFORD
[illegible] OF FILTRATION PLANT IN STAMFORD
[illegible] [illegible]
[illegible] FEET [illegible]

DATE FROM TO	TIME OF DAY	DEPTH FEET	[illegible] [illegible] MG/L	[illegible] TOT KJEL N MG/L	[illegible] NITRA TOTAL N MG/L	[illegible] PHOS-DIS ORTHO MG/L P	[illegible] PHOS-TOT MG/L P
[illegible]	[illegible]		[illegible]	1.100	0.070	0.038	0.046
[illegible]	[illegible]		0.15[illegible]	0.480	0.020	0.039	0.047
[illegible]	[illegible]		0.09[illegible]	1.200	0.045	0.035	0.060
[illegible]	[illegible]		0.05[illegible]	1.700	0.032	0.026	0.040
[illegible]	[illegible]		0.05[illegible]	1.250	0.040	0.030	0.050
[illegible]	[illegible]		0.09[illegible]	1.350	0.025	0.031	0.050
[illegible]	[illegible]		0.07[illegible]	1.400	0.035	0.027	0.046
[illegible]	[illegible]		0.05[illegible]	1.300	0.057	0.038	0.046
[illegible]	[illegible]		0.04[illegible]	1.100	0.010	0.038	0.022
[illegible]	[illegible]		0.03[illegible]	0.700	0.055	0.035	0.022
[illegible]	[illegible]		0.05[illegible]	1.000	0.029	0.035	0.070
[illegible]	[illegible]		0.02[illegible]	1.000	0.045	0.025	0.038

STORET RETRIEVAL DATE 74/03/10

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]						
TO	DAY	FEET	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]